HIRDLS Validation Status

(v2.04.09)

B. Nardi, J. Gille & HIRDLS Team

AURA, Science Meeting
Pasadena, Oct 1-5, 2007

Overview

Temperature validation

Ozone validation

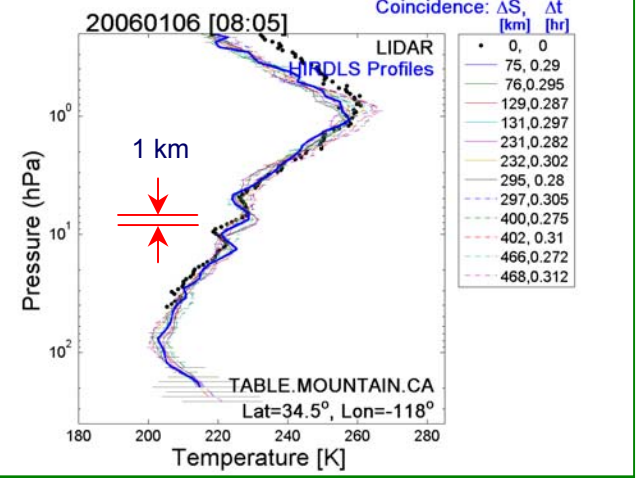
Nitric Acid validation

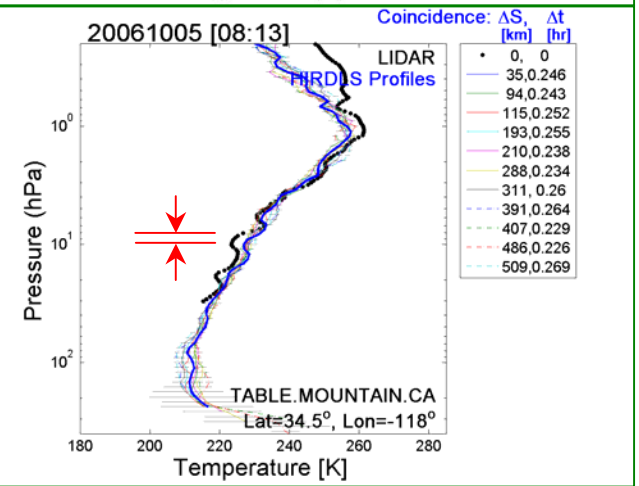
Cloud counting/height validation

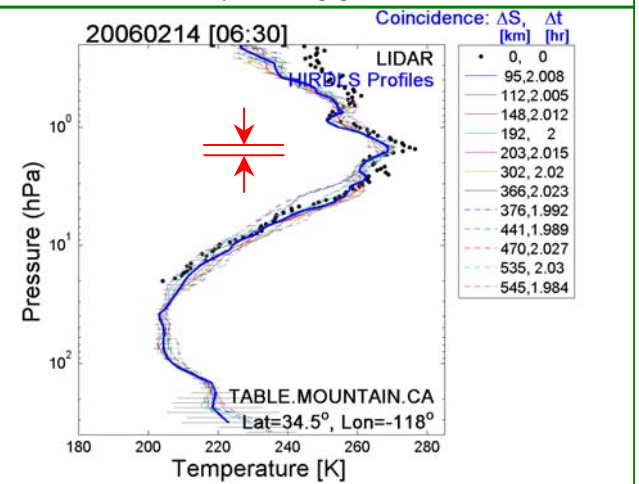
Summary

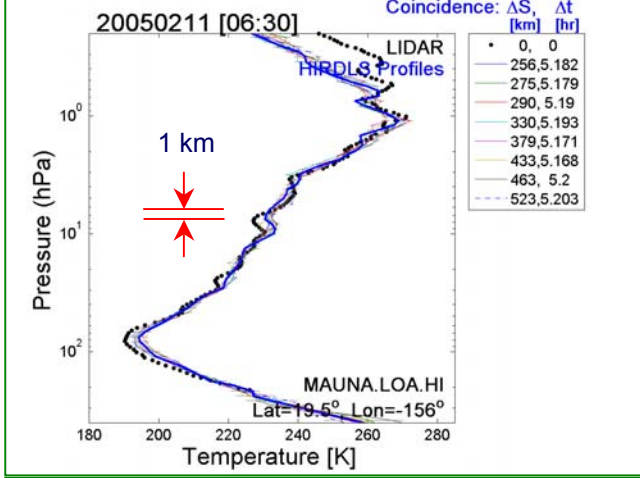
Temperature

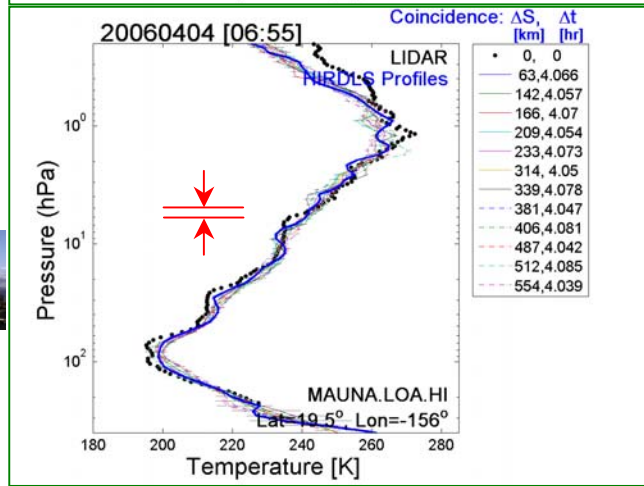
Temperature Lidar Profile Comparisons

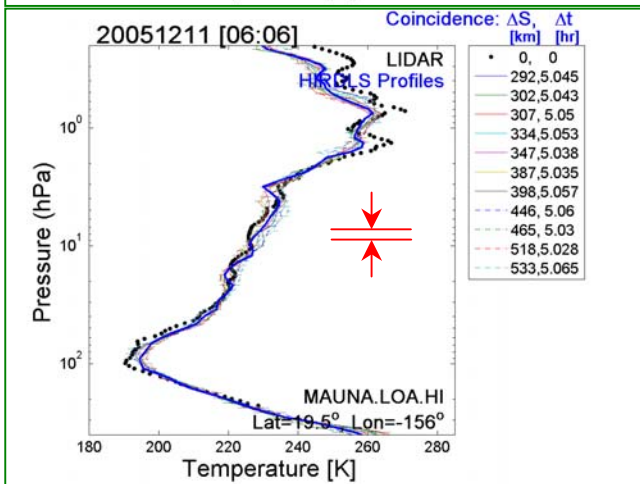












TMF
[34.5°N, 118°W]

MLO
[19.5°N, 156°W]

Temperature Lidar comparisons – Statistical Differences

Mauna Loa Observatory [19.5°N, 156°W]

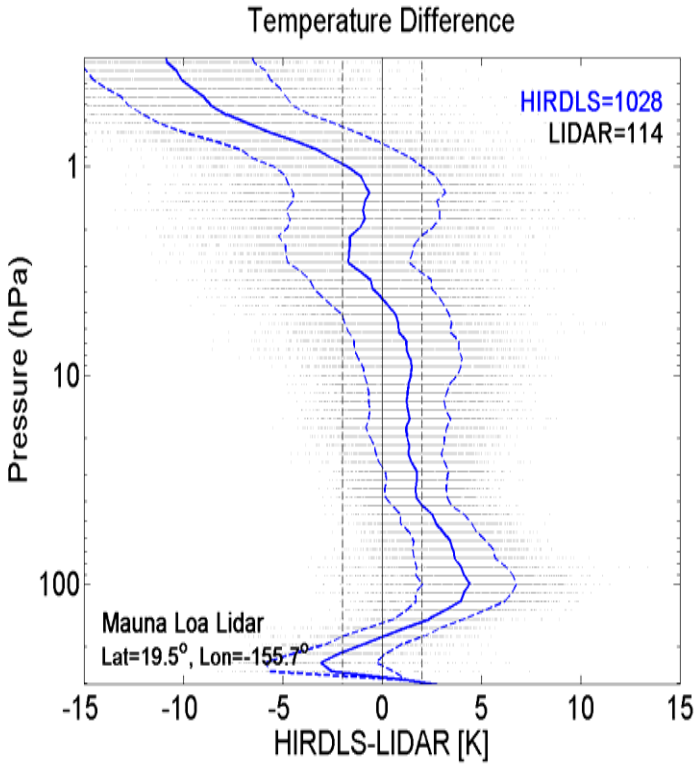
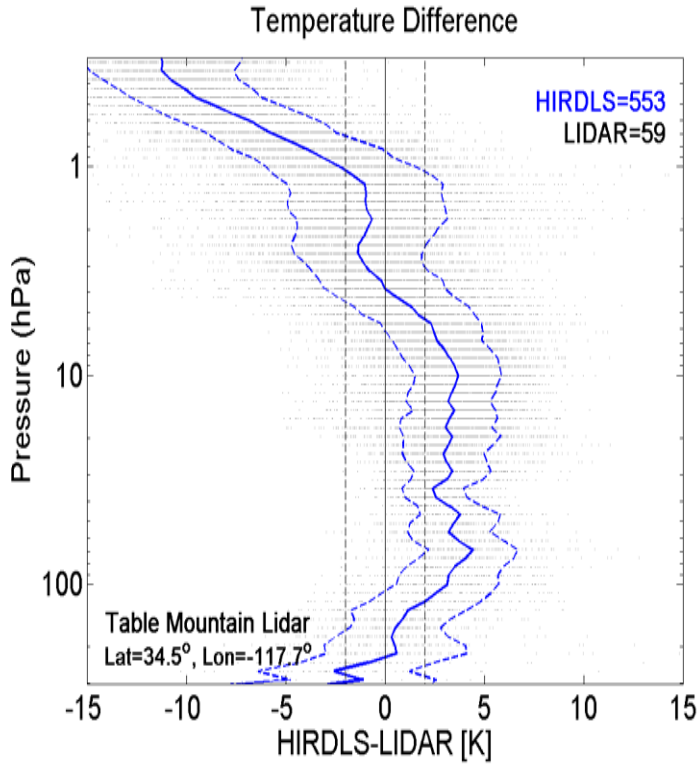
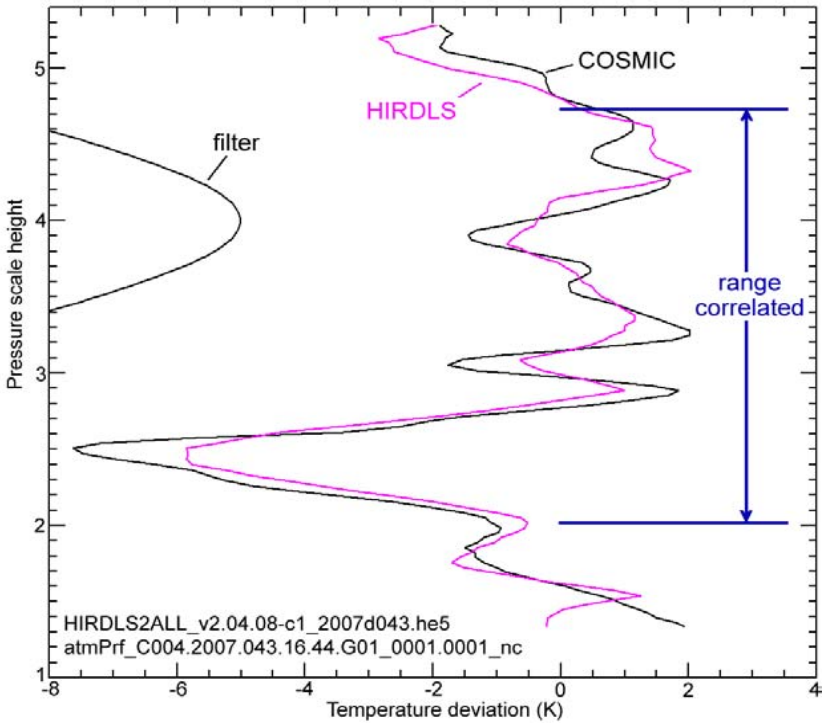


Table Mountain Facility [34.5°N, 118°W]



Coincidence = 560 km, 12 hrs

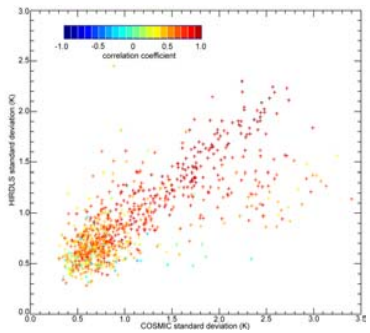
Temperature comparison with COSMIC/GPS, on small vertical distance scales.



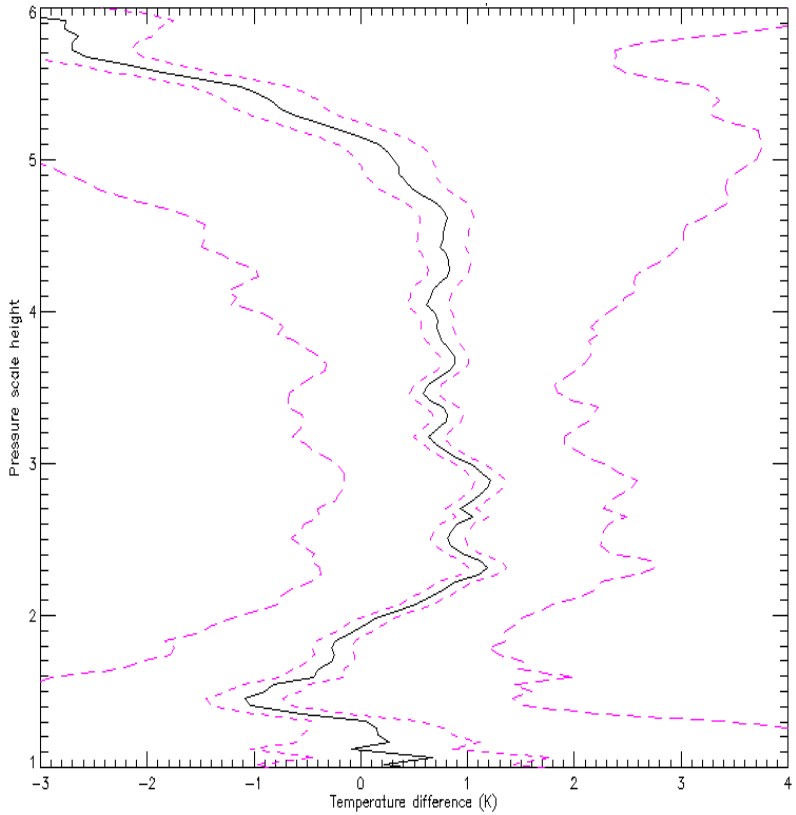
COINCIDENCE: Profiles were required to be within 0.75º great circle and 500 sec of each other, giving 888 pairs.

HIRDLS and COSMIC profiles were separately smoothed using a cosine bell filter of 2.8 km full width at half height (high pass filtered).

The deviations from these profiles were then intercorrelated over the range 2.0 to 4.75 pressure scale height.



Mean Differences



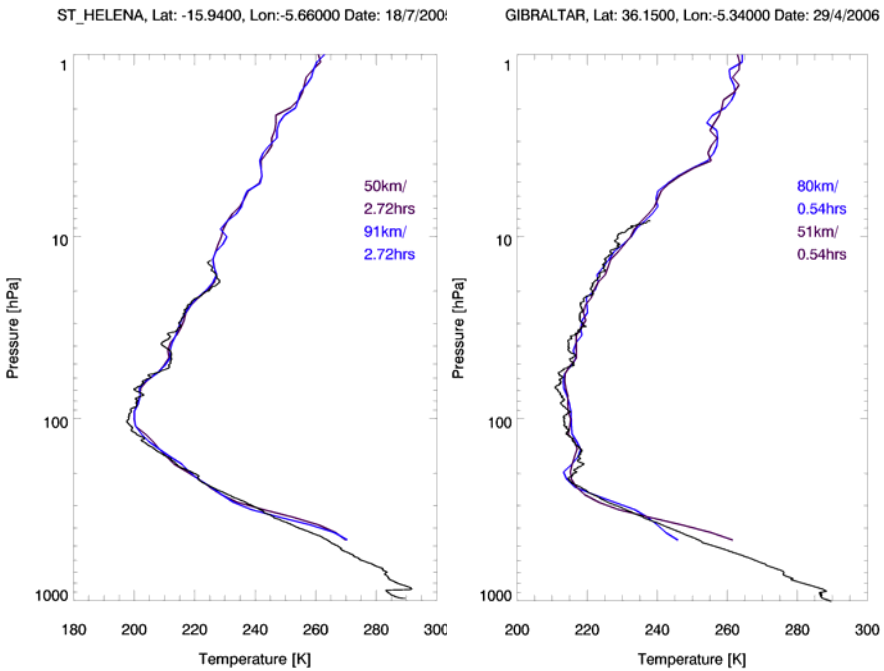
Mean difference, HIRDLS-COSMIC, for the Double COSMIC+HIRDLS coincidences. The solid line gives the difference, the outer dashed lines give the difference +/- the standard deviation of comparisons about the mean, and the inner dashed lines give the 1 standard deviation error bars of the mean.

The FORMOSAT-3/COSMIC constellation of six satellites, launched 14 April 2006, carries GPS receivers. Resolution = 1 km.

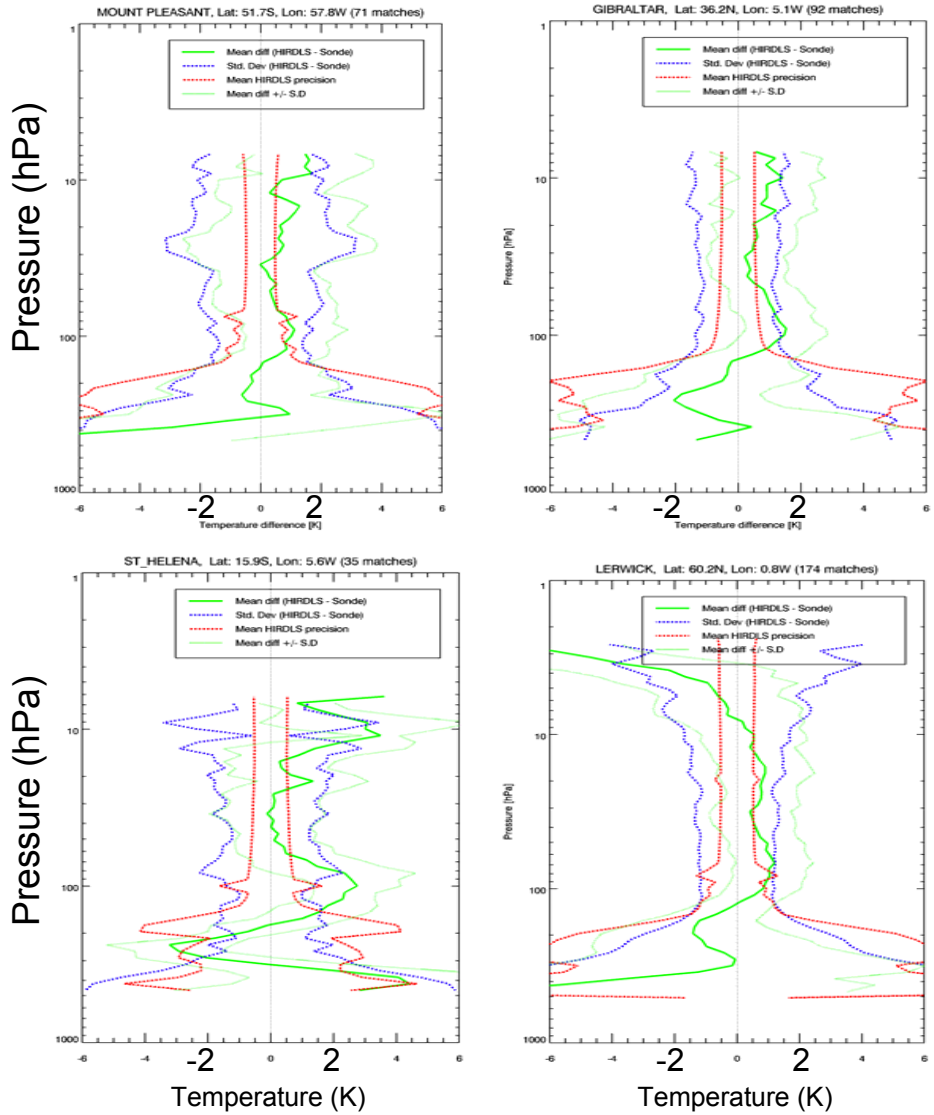
J.J. Barnett

Sonde Temperature Comparisons

Individual Profiles

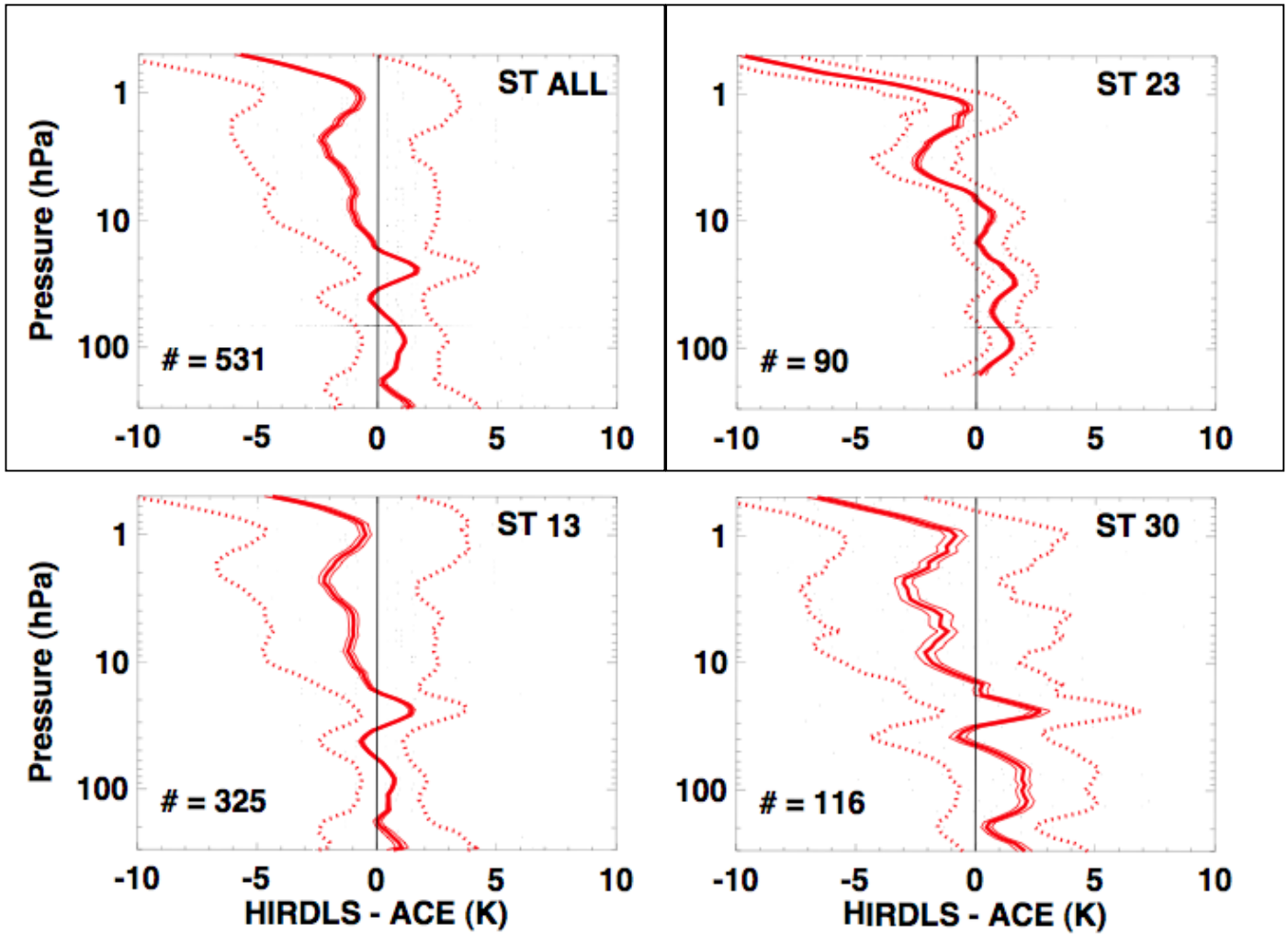


Statistical Differences



Gille et al, 2007

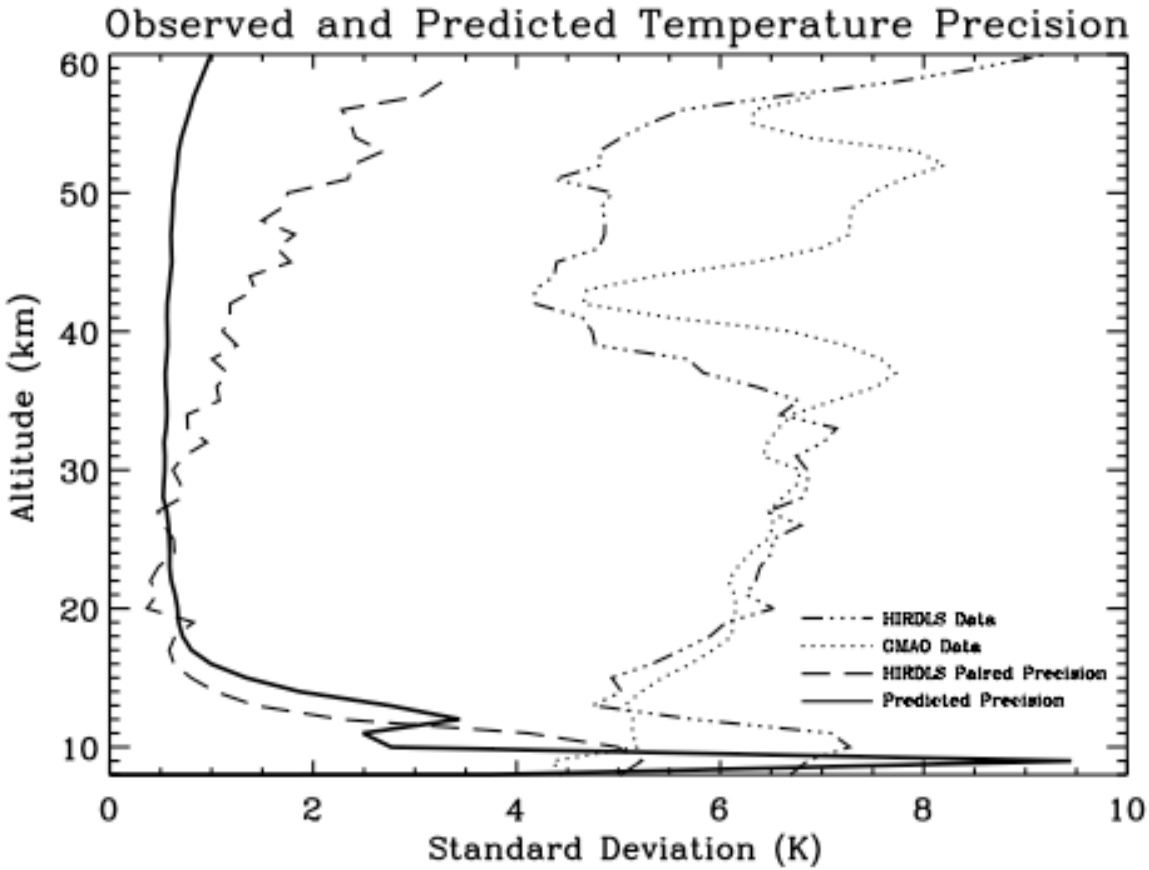
Temperature Comparison with ACE-FTS



Average temperature differences (solid, HIRDLS-ACE) and standard deviation (dashed).

Cora Randall

Temperature: Estimated Precision

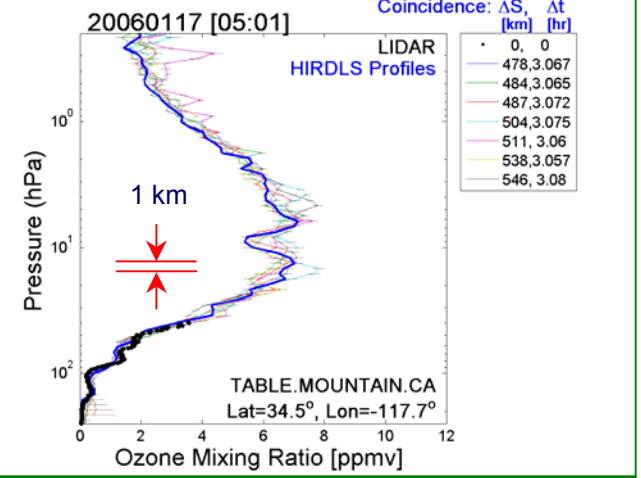


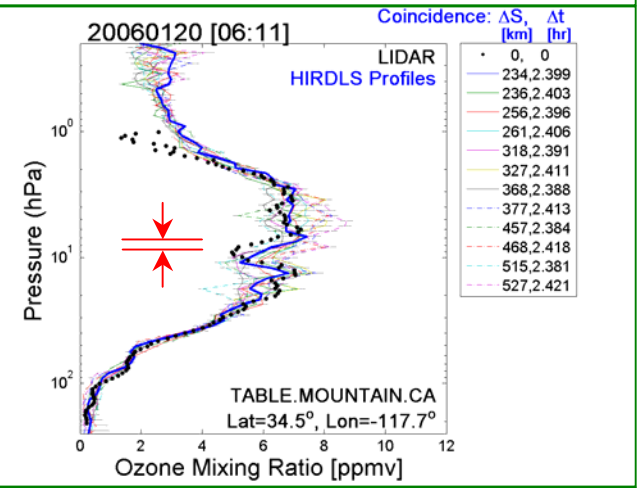
Empirically determined precision for HIRDLS determined from differences of paired profiles (dashed line) at latitude cross-over points at 80°N for 2 days in March and 2 days in September, compared total precision calculated by the retrieval code (solid line). The total variation of the GMAO and HIRDLS data for those situations are also shown.

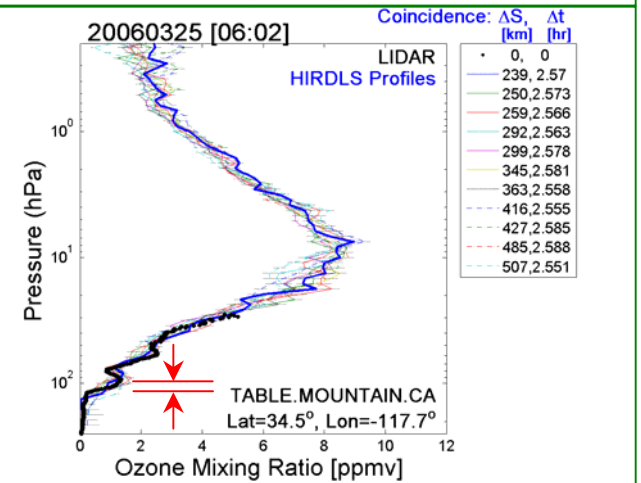
Gille et al, 2007

Ozone

OZONE Lidar Profile Comparisons







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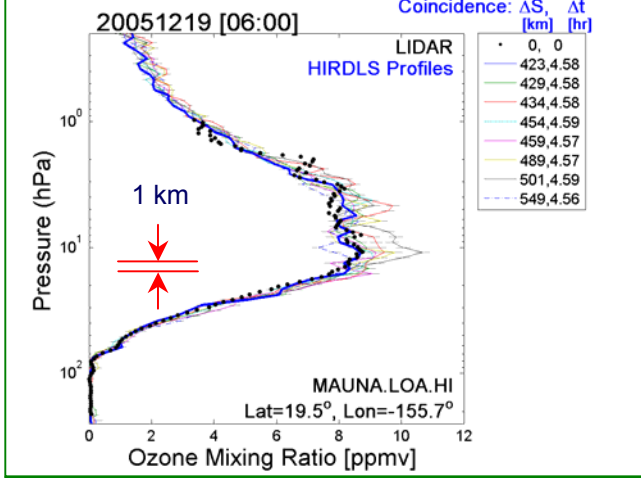
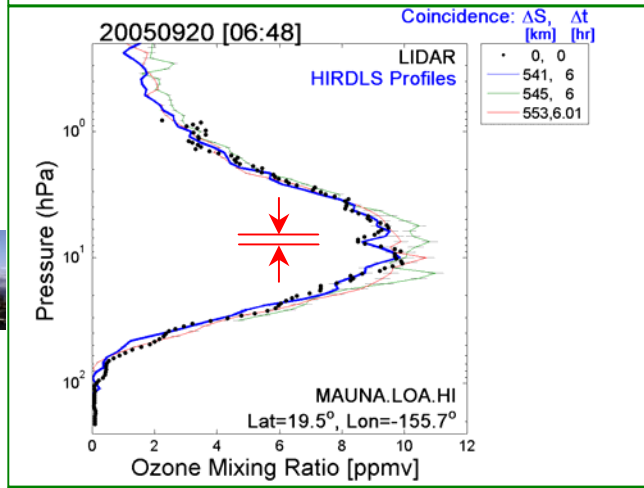
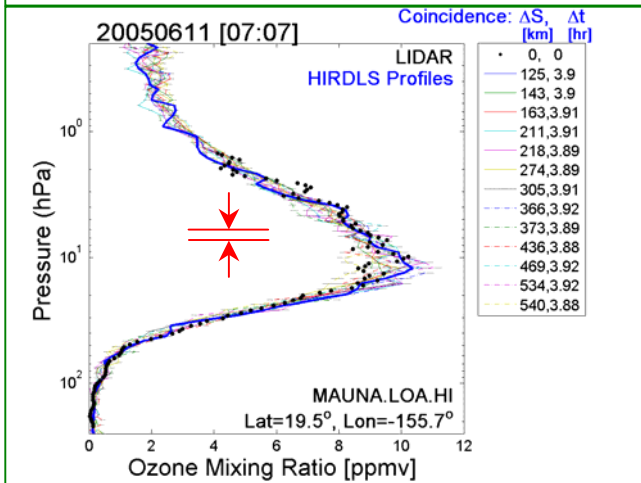
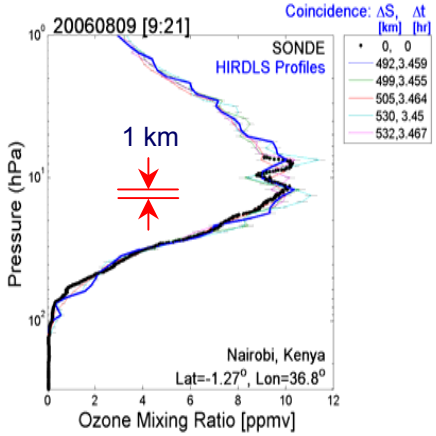
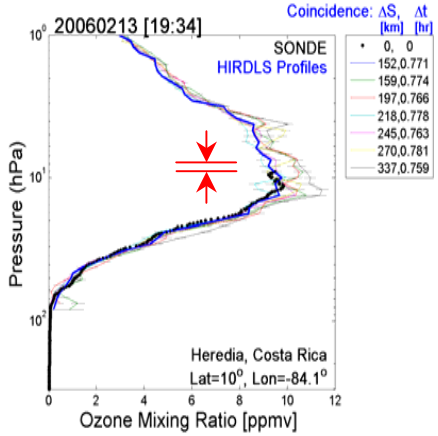


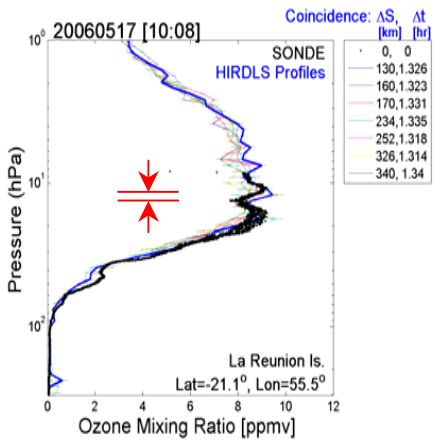


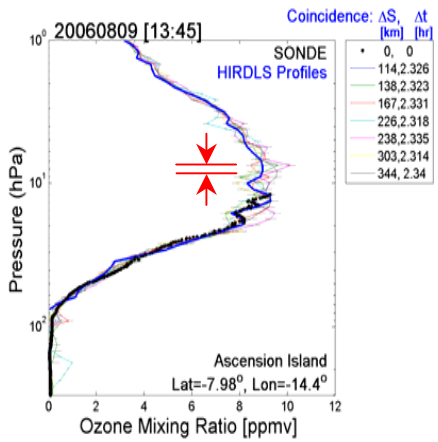


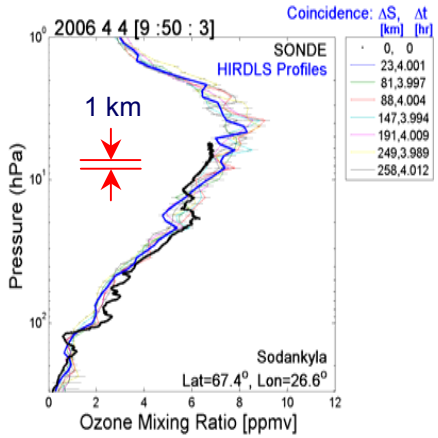
OZONESONDE Profile Comparisons

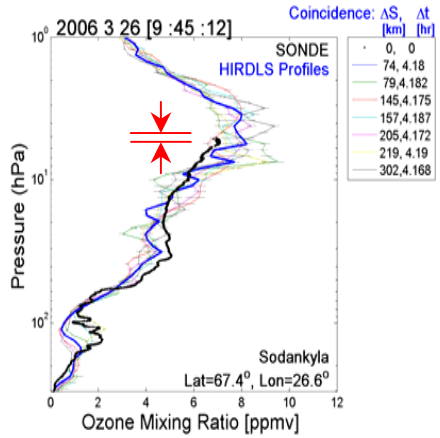


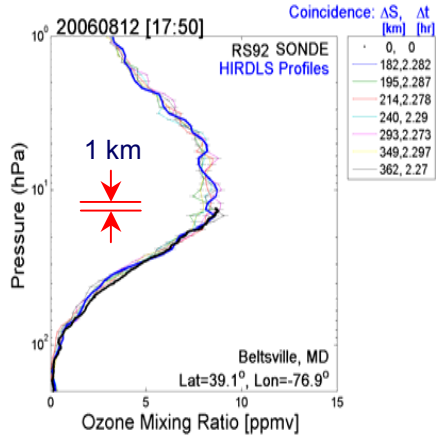


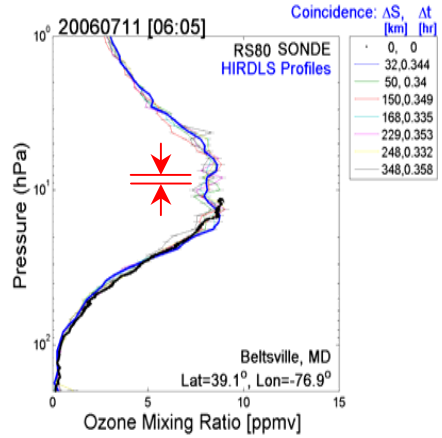












OZONE Lidar comparisons – Statistical Differences

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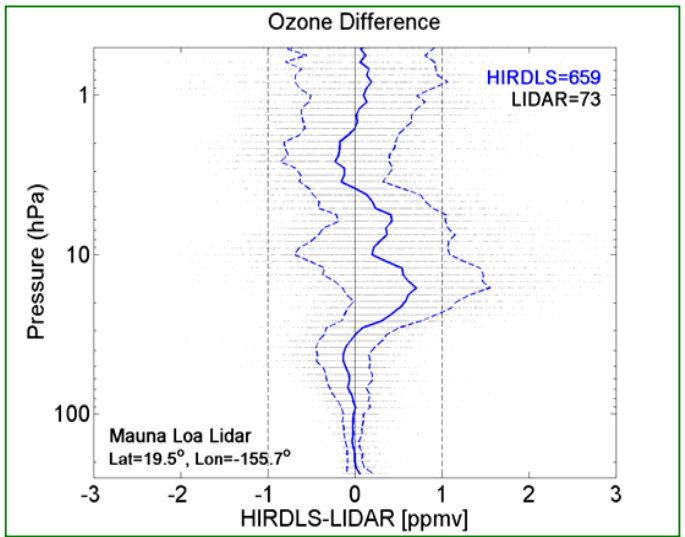

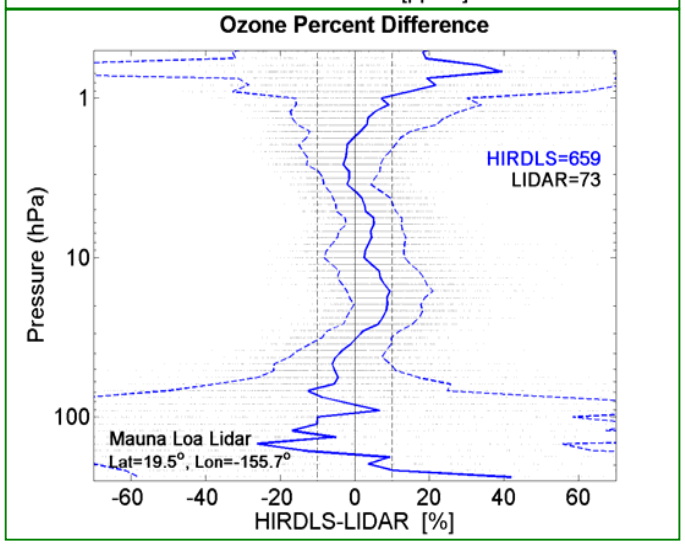

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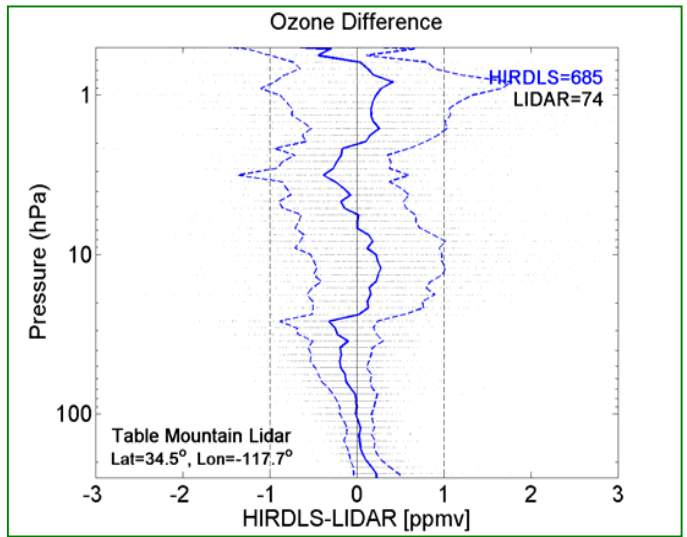
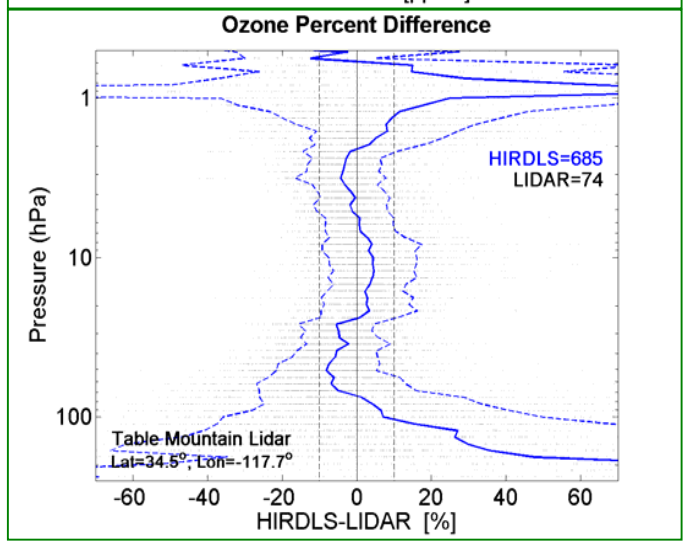
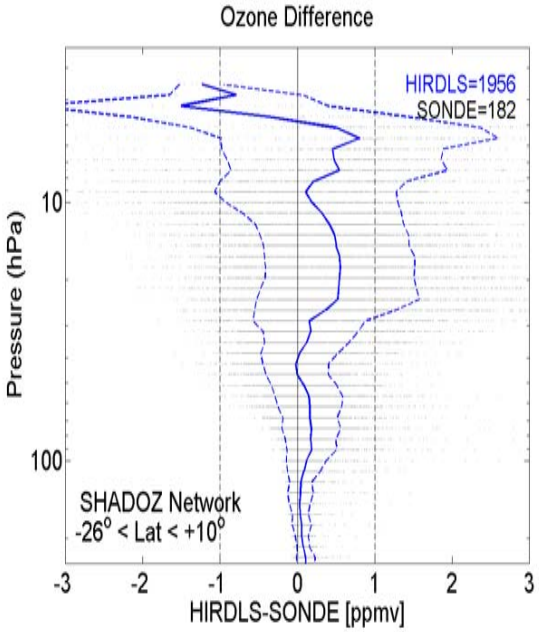
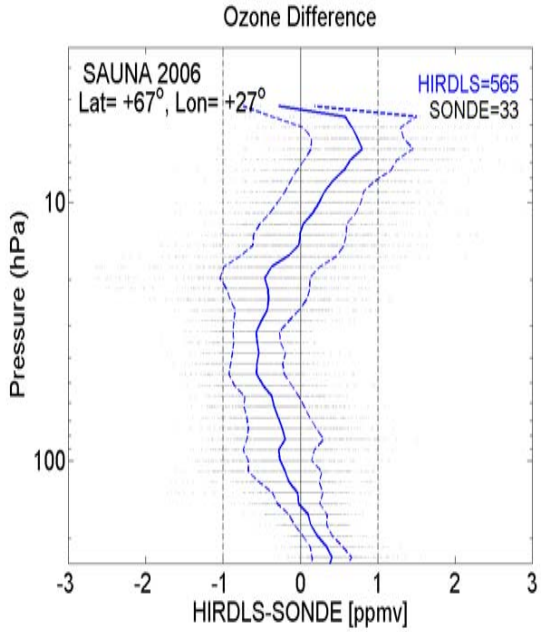
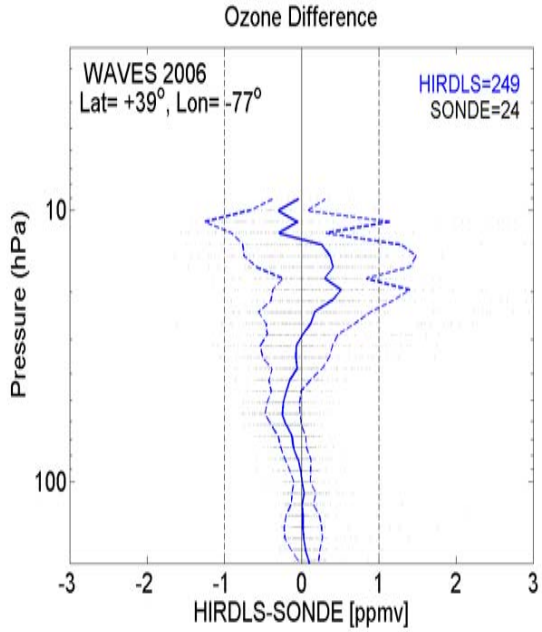


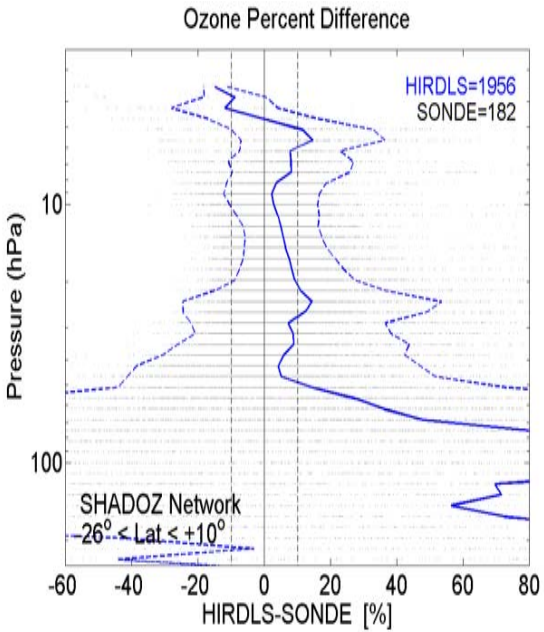


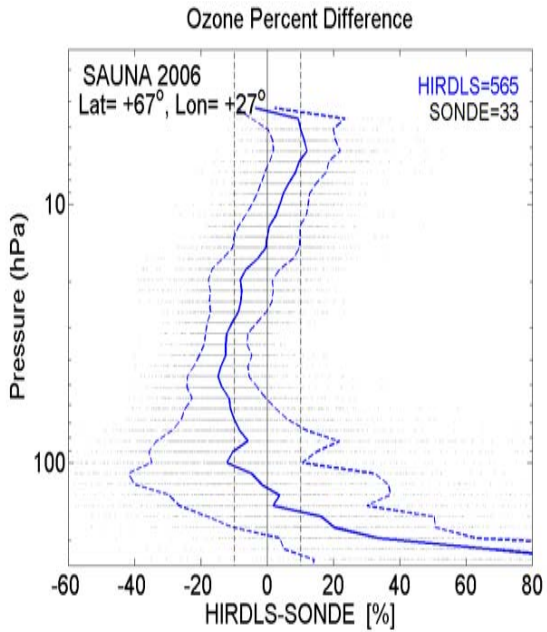
OZONESONDE Comparisons – Statistical Differences

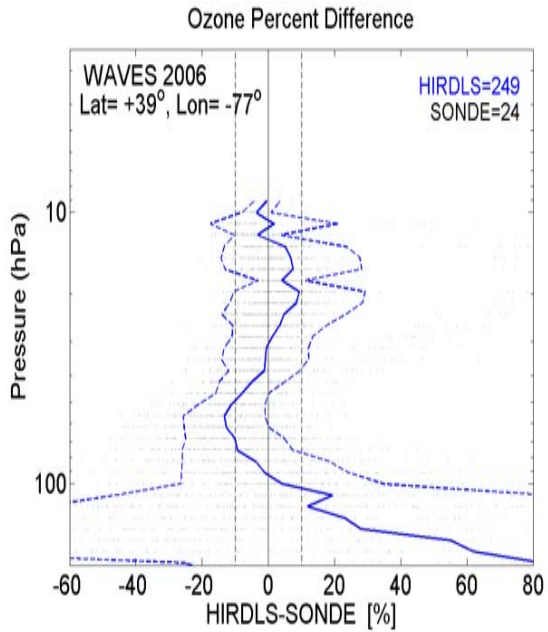




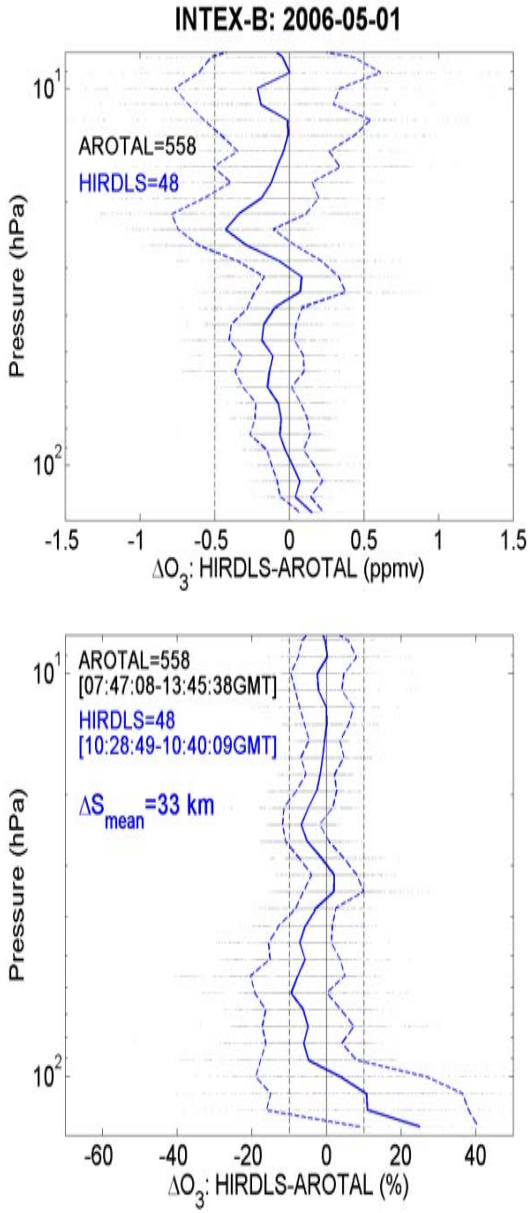


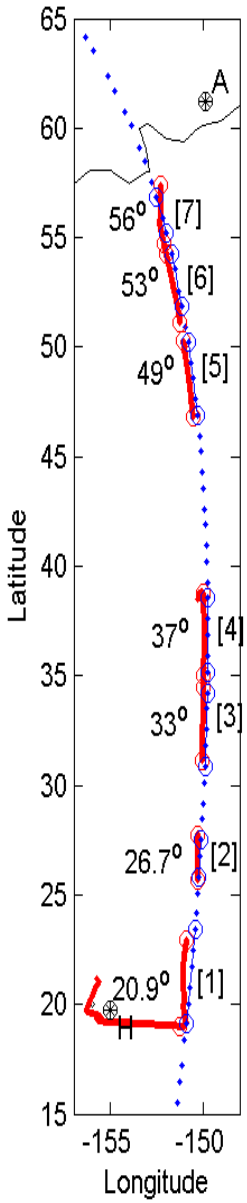


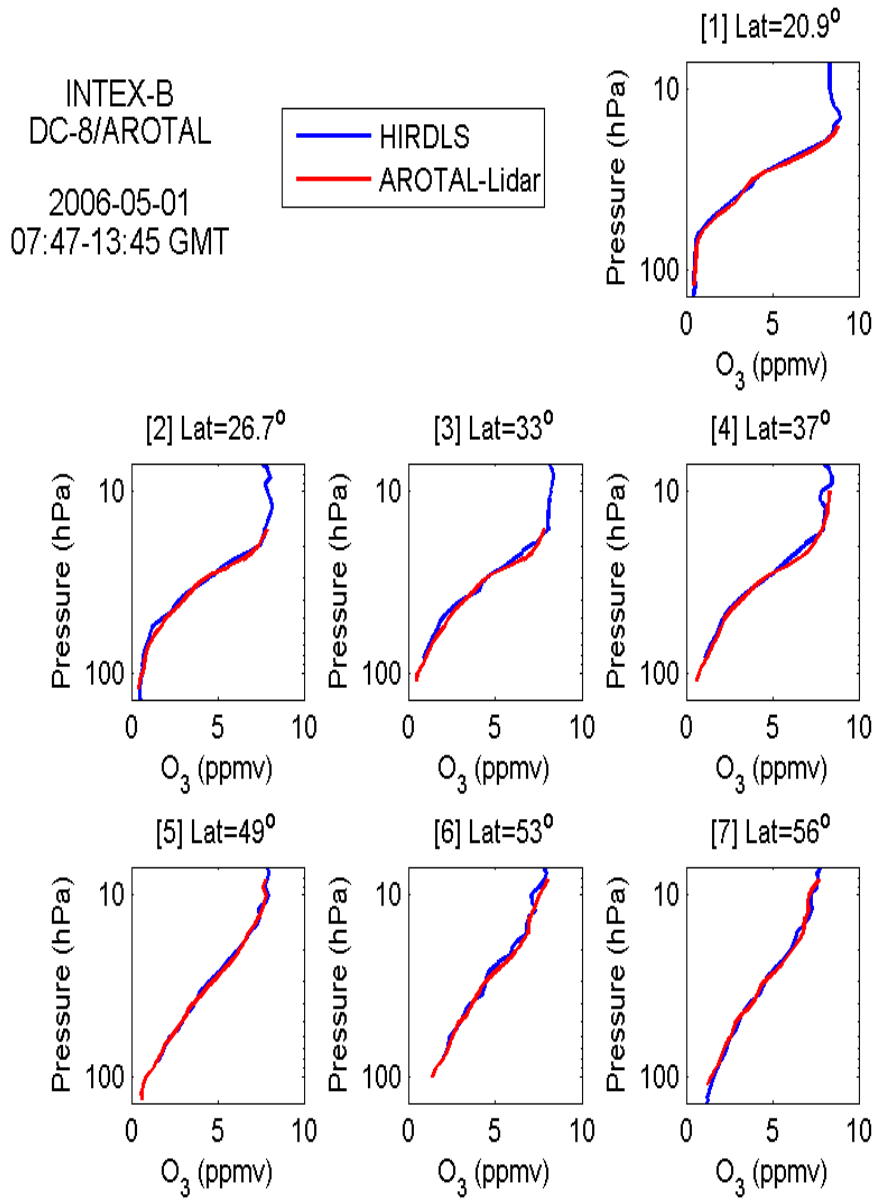




Ozone: INTEX-B AROTAL Lidar



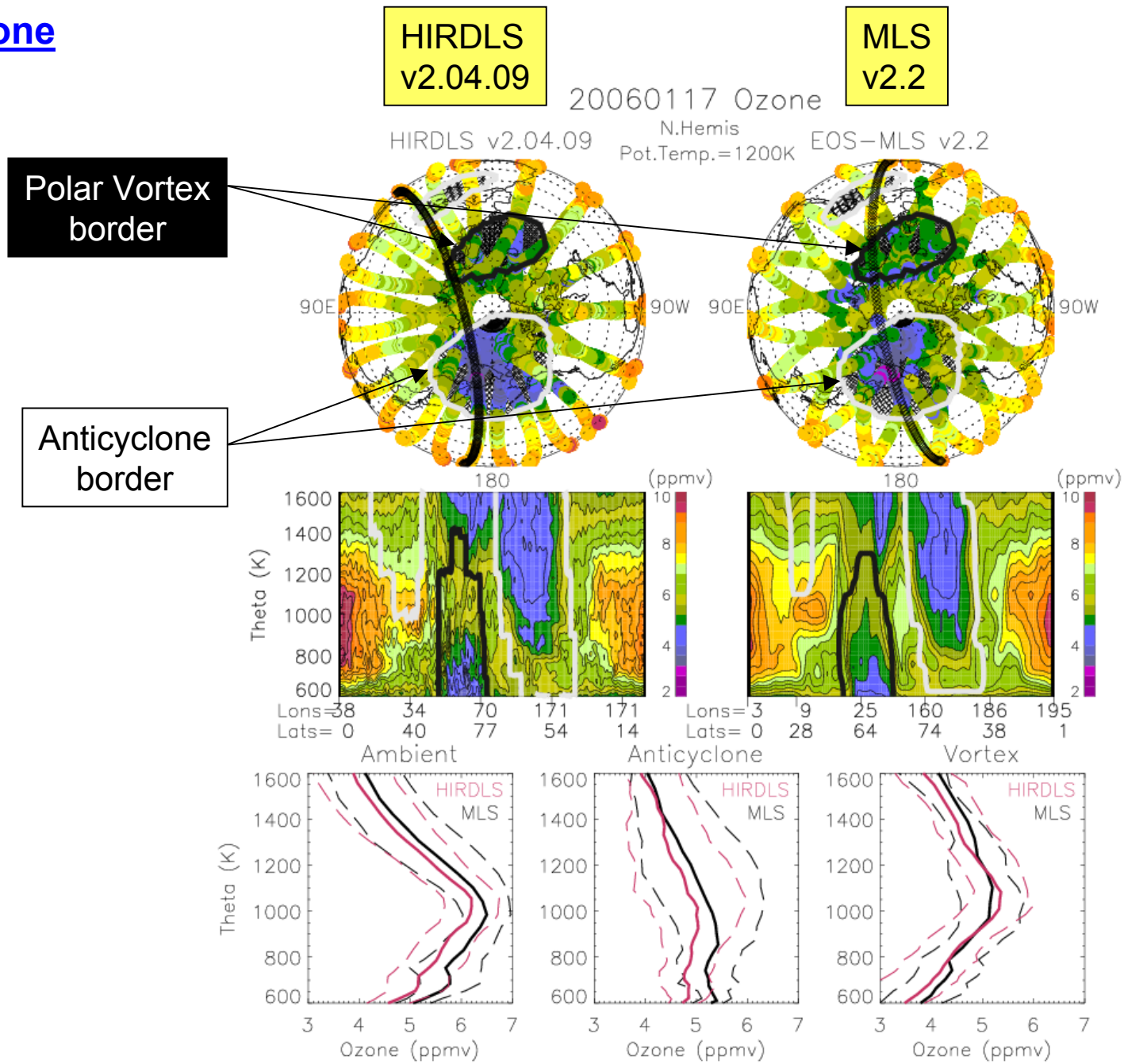




Ozone

HIRDLS v2.04.09

MLS v2.2

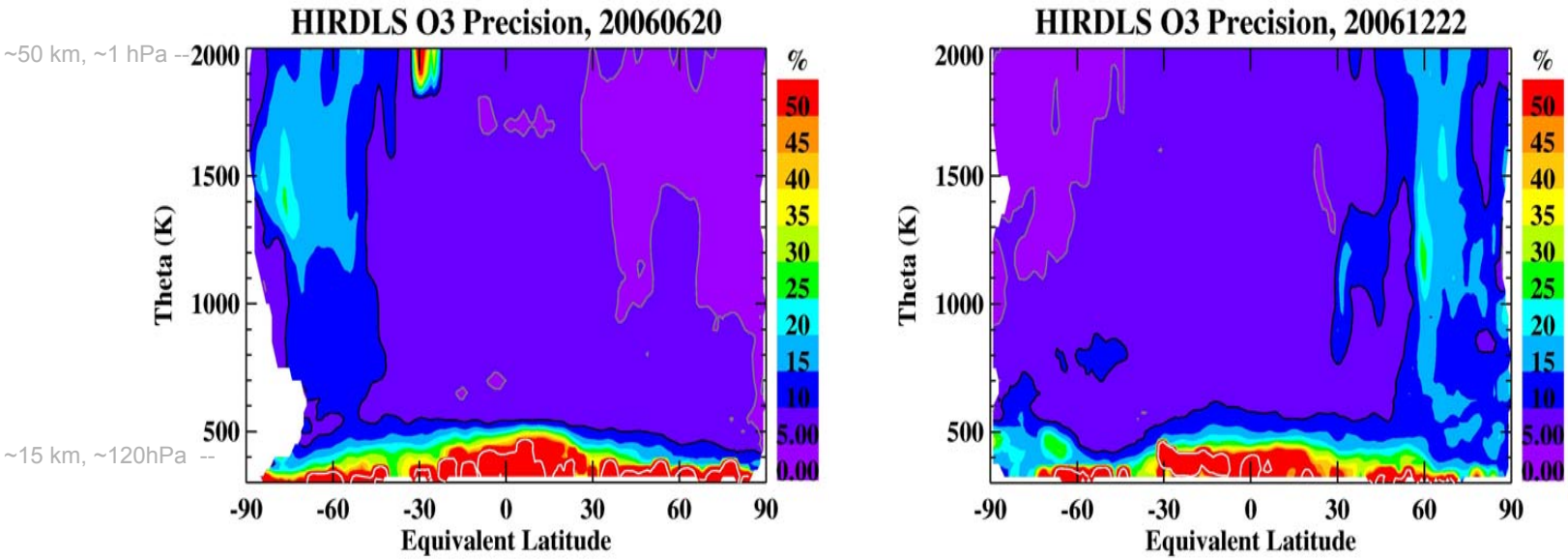


V. Lynn Harvey

Ozone Estimated Precision

June

December

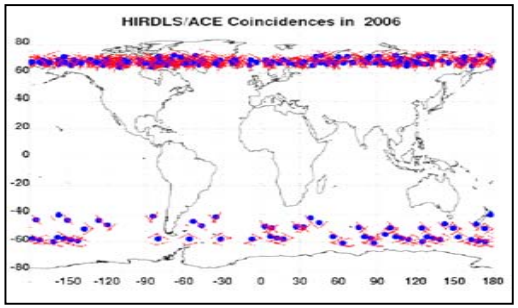


Shown is the ozone standard deviation in different equivalent latitude and potential temperature bins, an estimate of HIRDLS ozone precision. Results are given, in terms of percentage of mean, VMR for two days: 2006 June 20 (LEFT) and 2006 December 22 (RIGHT). In the bottom plots, the black lines highlight the 10% contour and the white lines highlight the 100% contour.

Cora Randall

Nitric Acid

HNO3: ACE-FTS comparisons

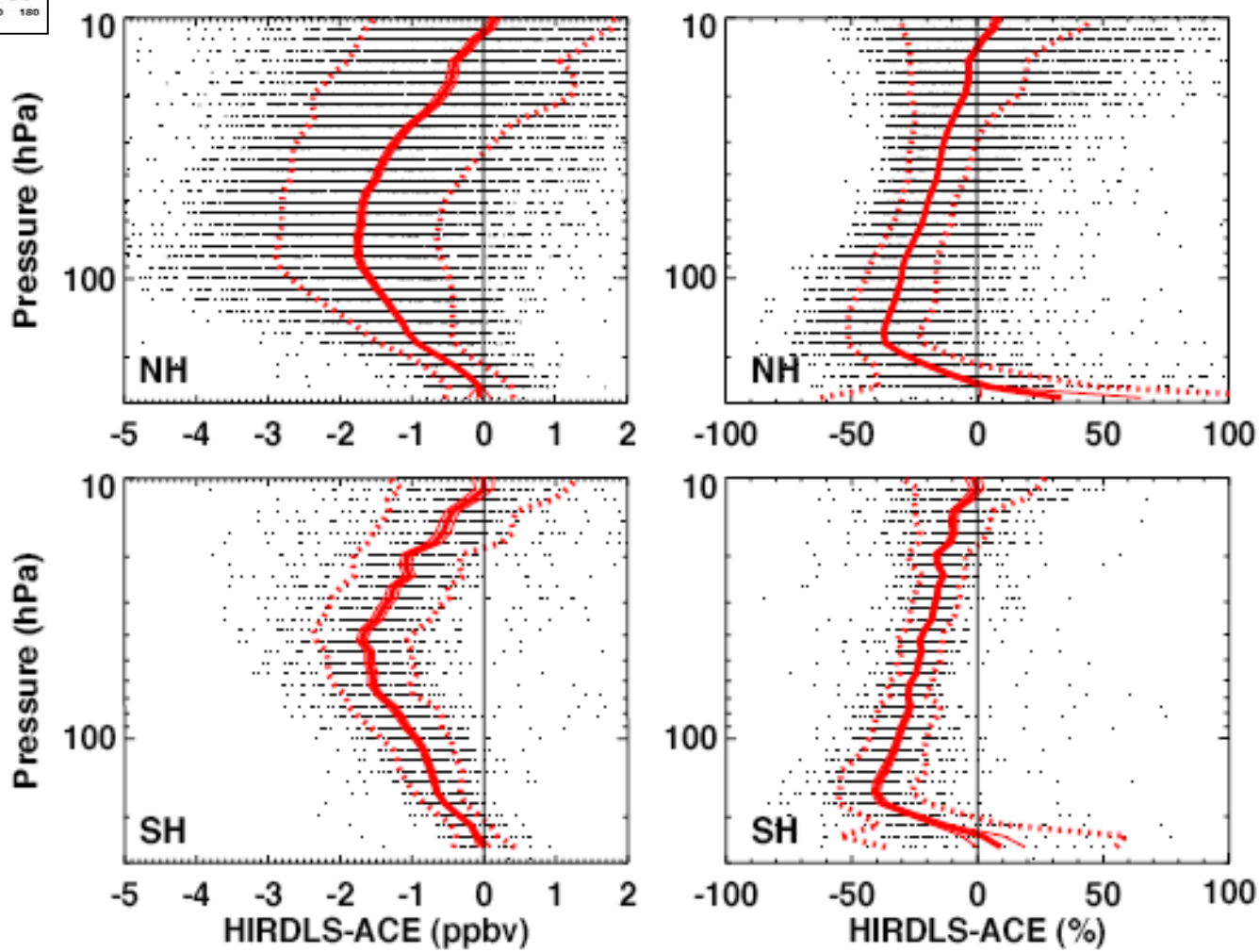


ΔVMR

%Difference

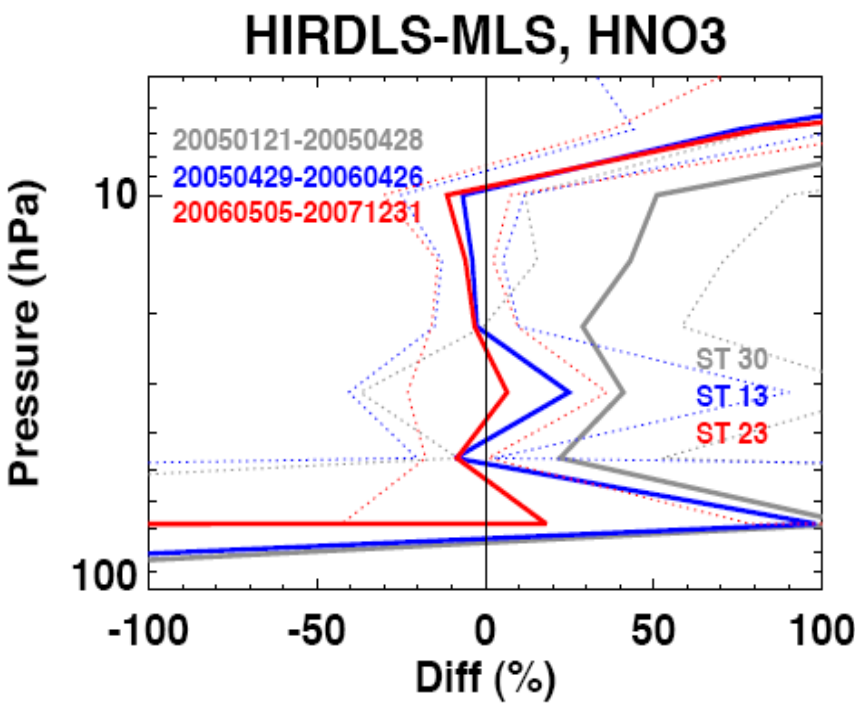
NH

SH



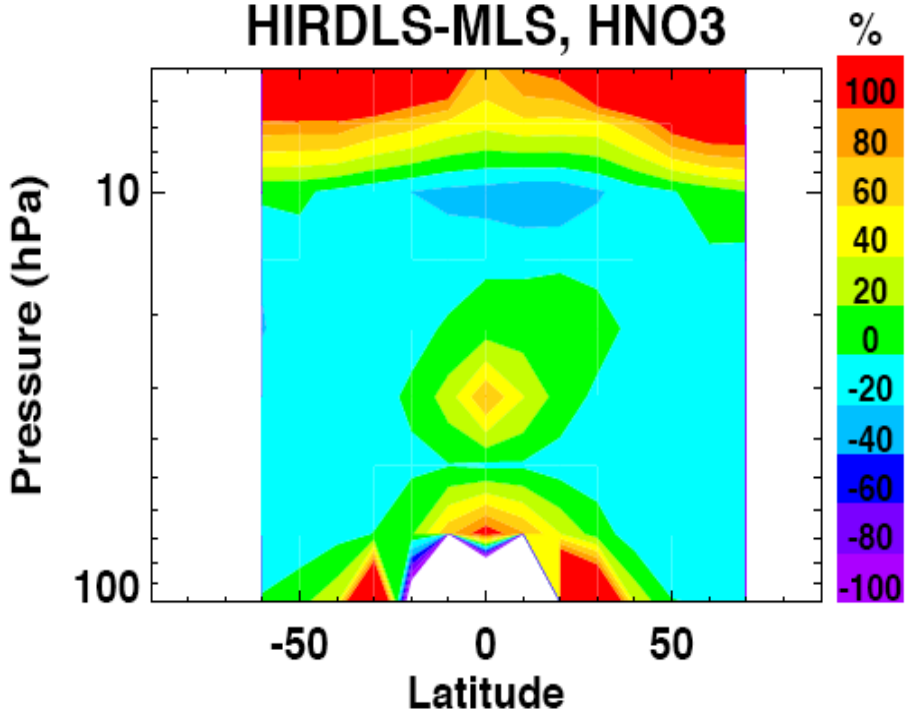
Cora Randall

MLS v2.2: Mean Percent Difference



Solid = Mean difference
Dashed = Std Dev of Difference

Percent Difference [10° zonal mean]

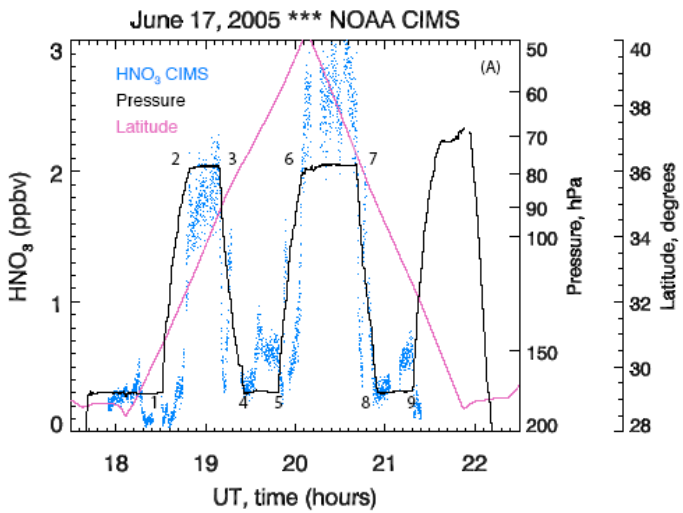


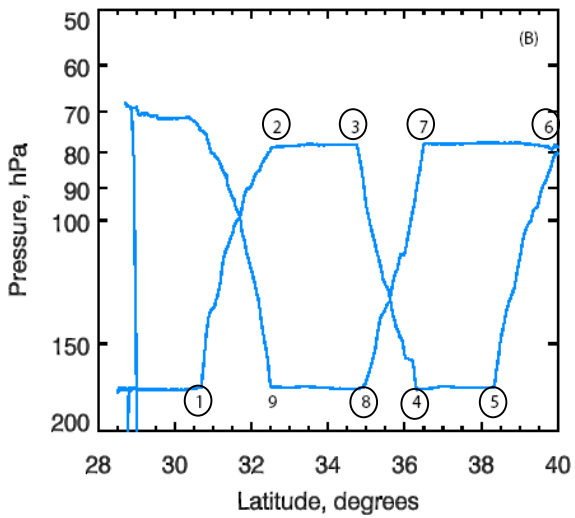
ST23 only = current Scan Table (since May 2006)

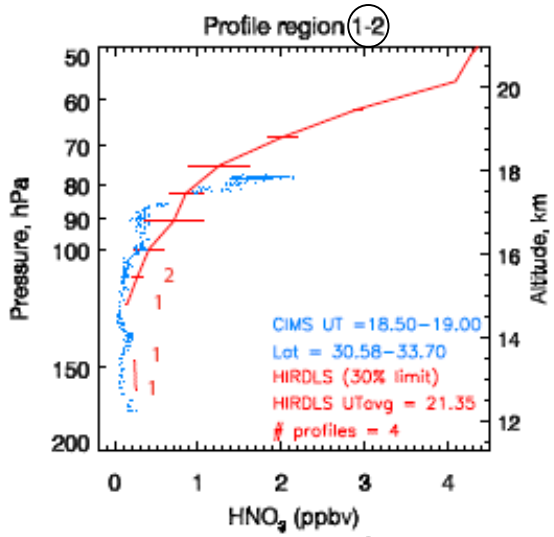
Over 278,000 coincidences within 1° latitude and 4° longitude. Theoretical precision criteria of ≤30% used.

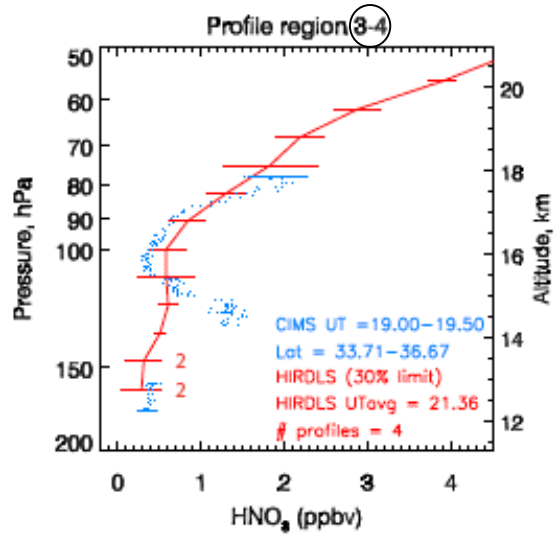
Cora Randall

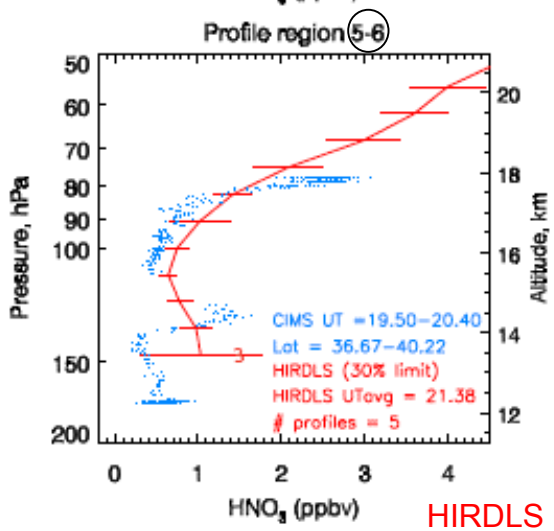
Airborne profile comparisons - Houston AVE [June 2005]

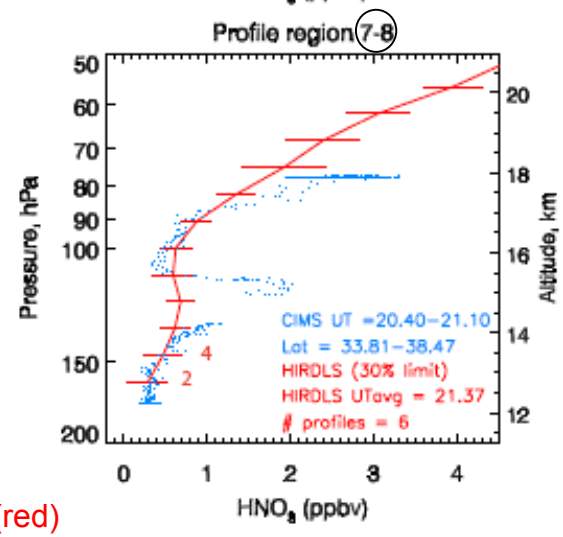












HIRDLS (red)
NOAA CIMS (blue)

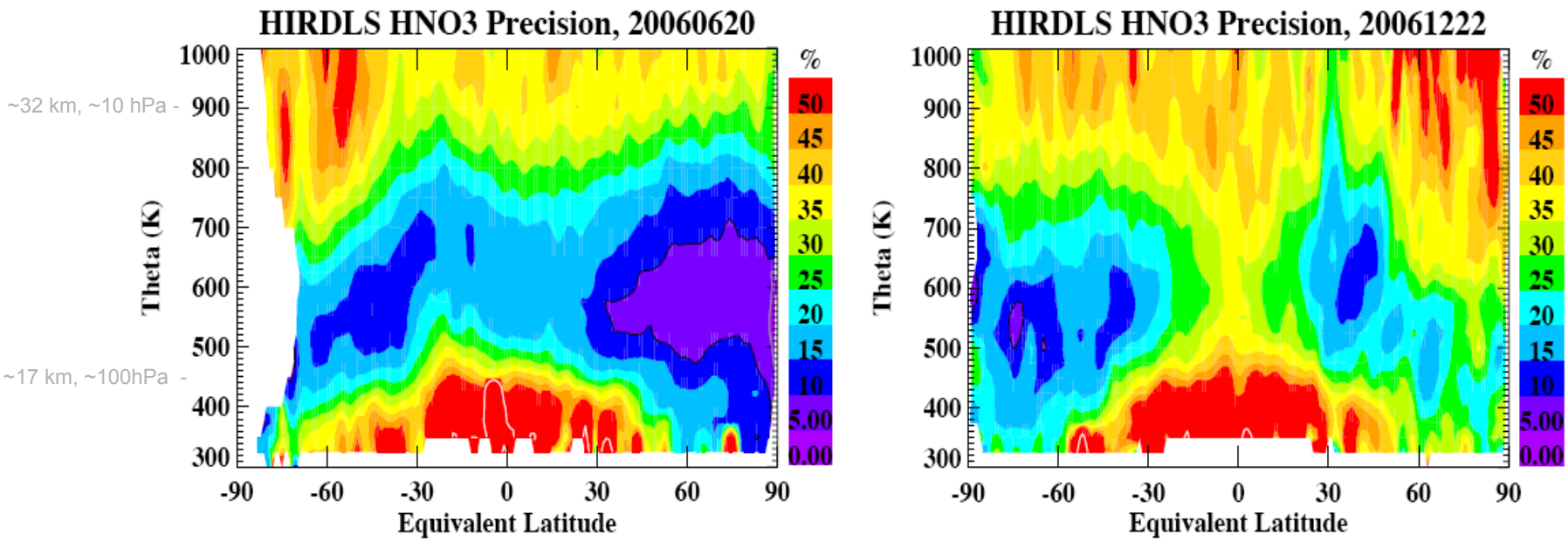
For this flight, HIRDLS HNO3 is broadly consistent with the NOAA CIMS instrument in the 100 hPa - 75 hPa region. Below this region, HNO3 filaments as measured by CIMS are not captured. The reason for this is currently not understood.

Kinnison et al, 2007

HNO3 Estimated Precision

June

December

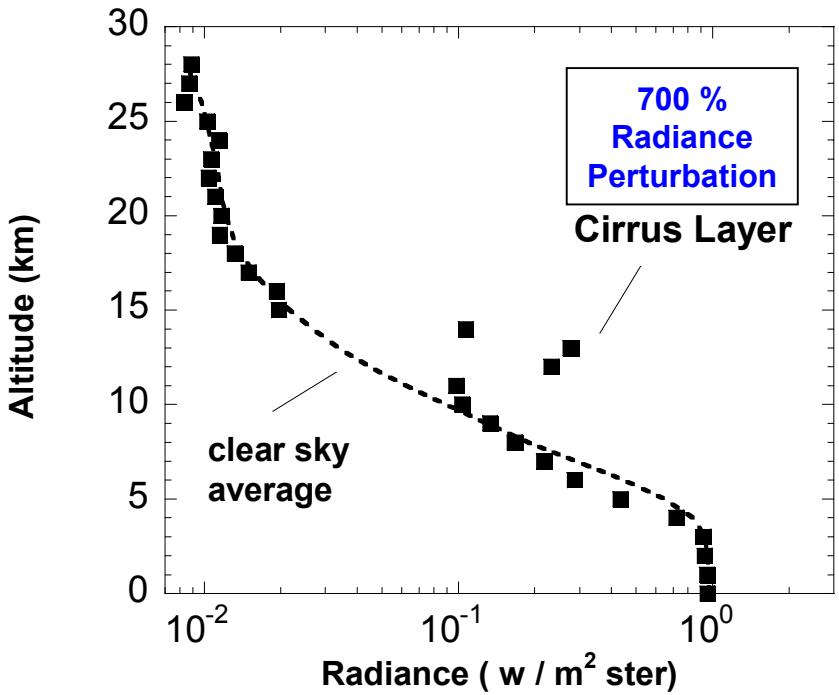


Shown is the HNO3 standard deviation in different equivalent latitude and potential temperature bins, an estimate of HIRDLS HNO3 precision. Results are given, in terms of percentage of the mean VMR, for two days: 2006 June 20 (LEFT) and 2006 December 22 (RIGHT). In the bottom plots, the black lines highlight the 10% contour and the white lines highlight the 100% contour.

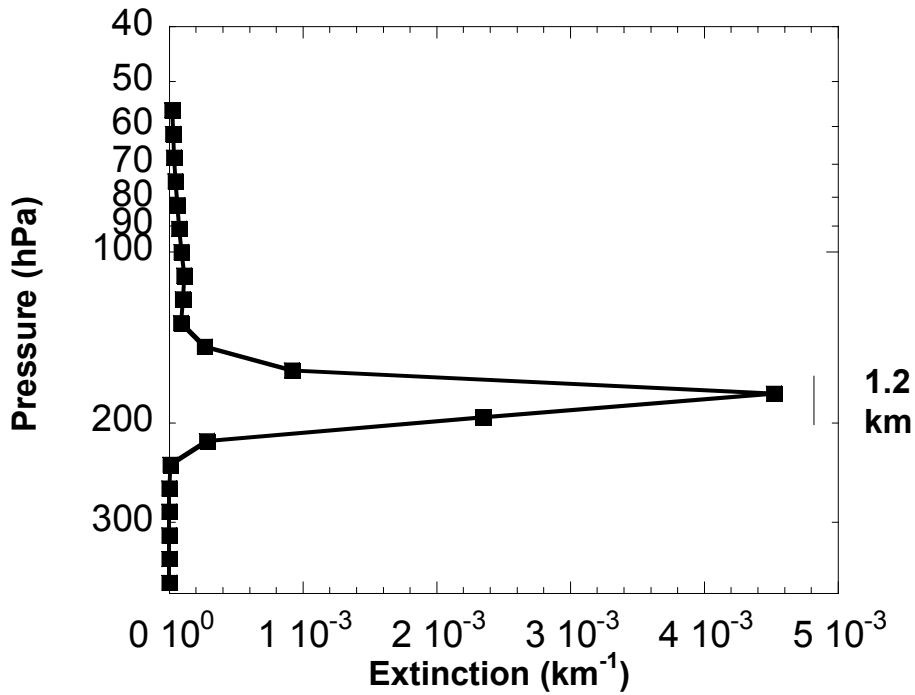
Clouds

Detection of Sub-Visual Cirrus Layer (12 μm, channel #6)

Tropical Cirrus Layer

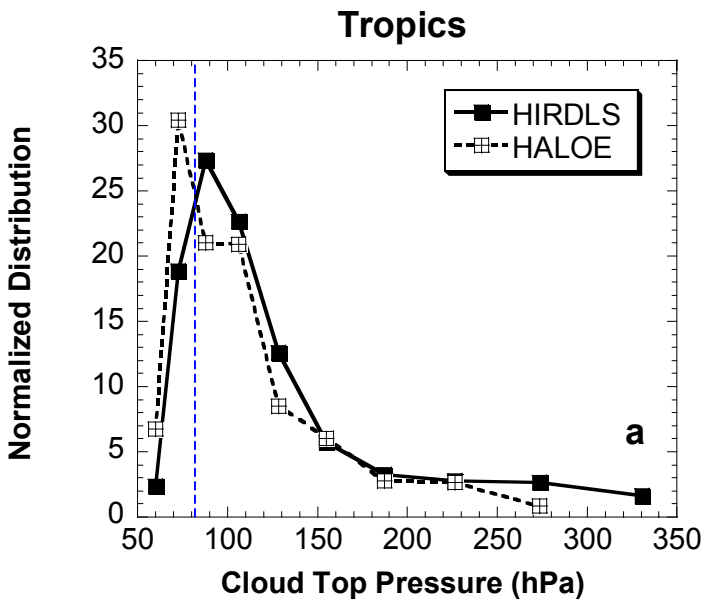


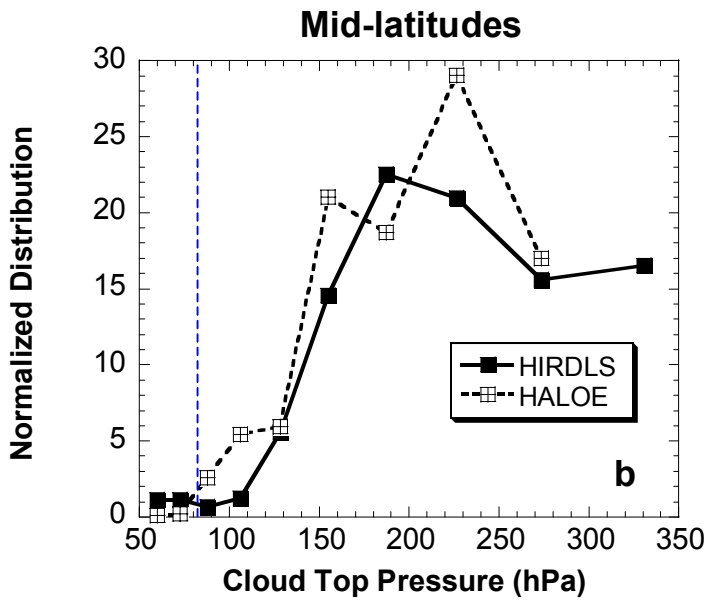
Cirrus Layer Extinction Profile



S. Massie

Cloud Top Pressure Determinations

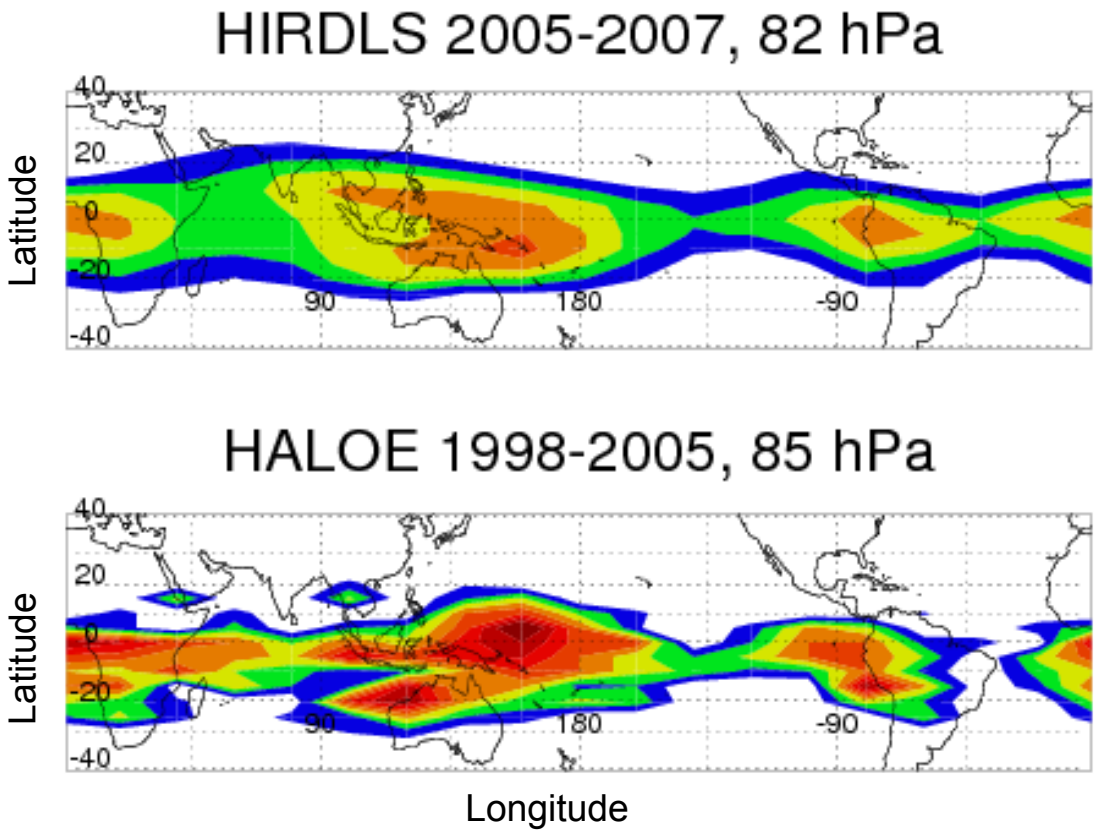




Compare the cloud counting capability of the HIRDLS with HALOE.

S. Massie

Cirrus Frequency of Occurrence



Derived from Radiance-based cloud detection algorithm. (types 1,2)

Derived from Multi-spectral Extinction (all clouds)

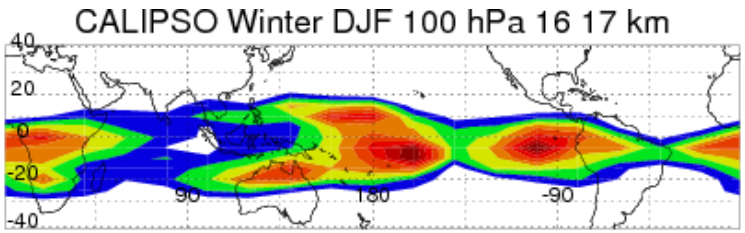
S. Massie

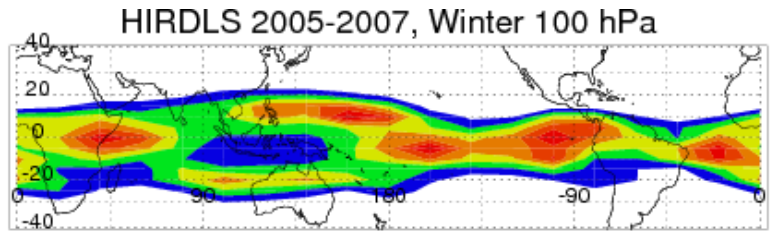
Seasonal Variations of Cirrus Layers

CALIPSO

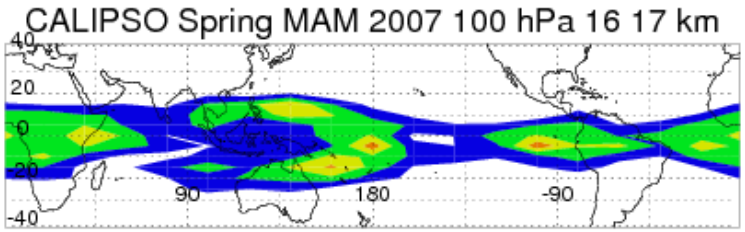
HIRDLS

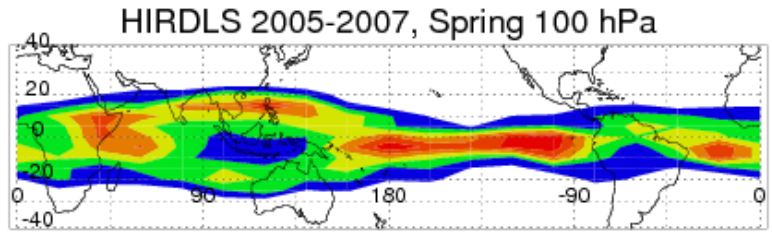
Winter NH



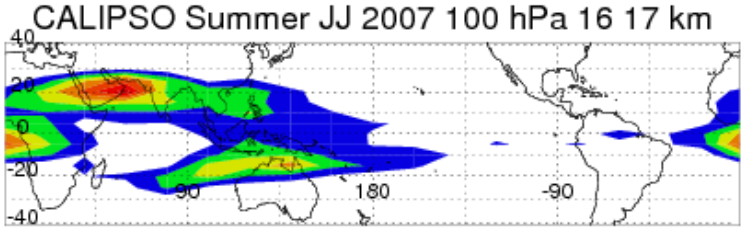


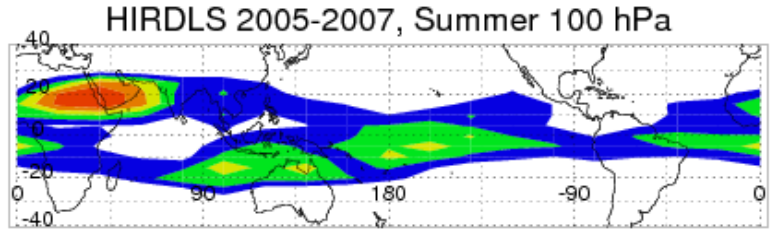
Spring NH



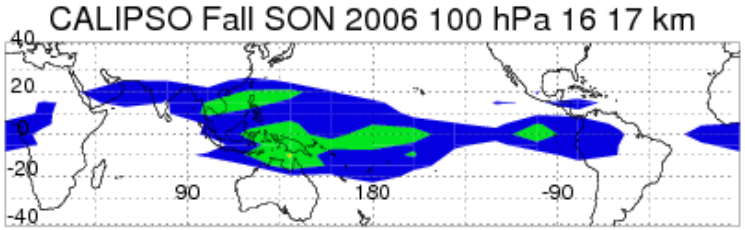


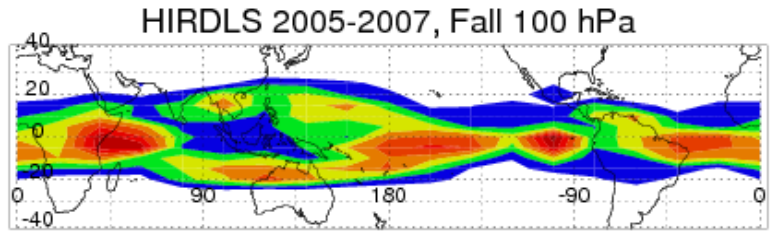
Summer NH

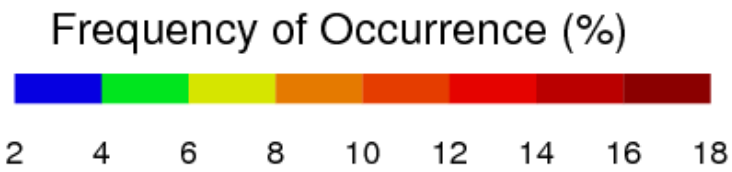


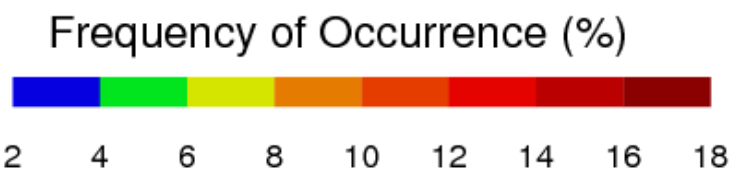


Fall NH









S. Massie

Summary of quality of validation products

Temperature:

P-Range: 1-300 hPa
Precision: 0.5K at 10-100 hPa; 1K @ 1 hPa (v2.02.07)
Accuracy: ±2K at 1-100 hPa

Ozone:

Range: 1-100+ hPa (mid-high Lat), 1-50 hPa (tropics)
Precision: 5-10%
Accuracy: 2-10% at 1-10 hPa; biased generally low
5% high bias ~10-30 hPa
0-20% low bias, ~30-100+ hPa (mid & high latitudes)

Nitric Acid:

Range: 10-100 hPa, 10-50 hPa (tropics)
Precision: 10-35% at 100-10hPa
Accuracy: ~10% (at 10hPa) to 30% (at 100hPa); biased low [ACE-FTS]

Clouds/Aerosol:

Range: 400 hPa- 10 hPa
Correlation with other instruments:
SAGE & HALOE (cloud-top pressure): 0.85 - .93
CALIPSO horizontal cloud scale: 0.99
Extinction retrieval successful at rate 70%: needs improvement

Vertical Resolution: 1-2 km

(See posters, Wednesday)

Status of HIRDLS data products

1. Temperature, Ozone, HNO_3, clouds – Released [v2.04.09]

2. H_2O, CFC-11, CFC-12 – Not ready to release;
now most promising for future releases

3. CH_4, NO_2, N_2O, $ClONO_2$, N_2O_5 – Not ready to release.

List of Validation & related publications

- Alexander et al, Global Gravity Wave Momentum Flux, JGR, In Review.
- Coffey et al, Ozone observations during the Polar Aura Validation Experiment (PAVE) in support of EOS Aura validation, JGR, In Review.
- Coffey et al, Airborne Fourier transform spectrometer (FTS) observations in support of EOS Aura validation, JGR, In Review.
- Gille et al, The High Resolution Dynamics Limb Sounder (HIRDLS): Experiment Overview, Results and Validation Of Initial Temperature Data, JGR, In Review.
- Kinnison et al, Global Observations of HNO3 from the High Resolution Dynamics Limb Sounder (HIRDLS) – First results, JGR, In Review.
- Massie et al, HIRDLS Observations of Clouds, JGR, *Accepted*.
- Nardi et al, Validation of HIRDLS Ozone Measurements, JGR, In Review.

Other relevant HIRDLS publications

Khosravi et. al. (2007) Retrieval Algorithm and Characterization for the High Resolution Dynamics Limb Sounder (HIRDLS), in preparation for submission to *IEEE Trans. Geosci. Remote Sens.*

Eden, T., J.J. Barnett, J.C. Gille, C.L. Hepplewhite, C.W.P. Palmer, J.G. Whitney (2007), Spectral Characterization of the HIRDLS Flight Instrument from Pre-launch Calibration Data, in preparation.

Barnett, J.J., J.N. Bracken, K. Djotni, C.L. Hepplewhite, J.L. Moorhouse, O.O. Oduleye, C.W.P. Palmer, D.M. Peters, L.A. Rokke, T.W. Walton, R.E.J. Watkins, J.G. Whitney, J.C. Gille, P.I. Arter, T.D. Eden, B. Nardi (2003), Pre-launch calibration of the NASA AURA HIRDLS instrument, *Proc. SPIE* **5152,** 172-180.

Gille, J.C., J.J. Barnett, J.C. Whitney, M.A. Dials, D.M. Woodard, W. Rudolf, A. Lambert, W. Mankin (2003), The High Resolution Dynamics Limb Sounder (HIRDLS) Experiment on Aura, *Proc. SPIE* **5152,** 162-171.

Hepplewhite, C.L., J.J. Barnett, J.C. Whitney, C.W.P. Palmer, O.O. Oduleye, T. Walton, M.A. Dials, J.C. Gille, T. Eden, B. Nardi (2005), HIRDLS Functional Performance in Orbit – A summary, Proc. SPIE **5883**, J1-10.

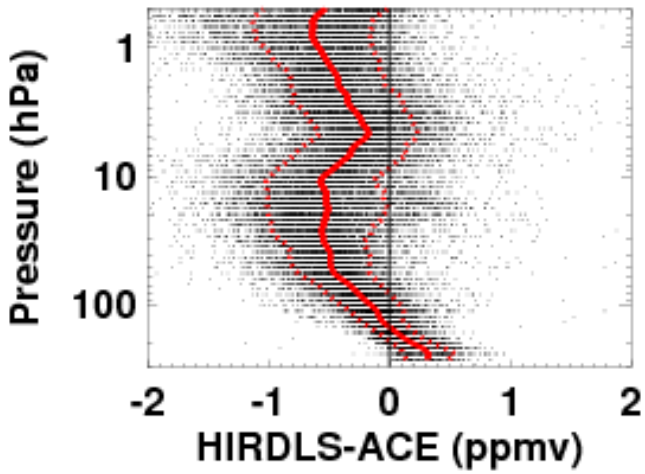
Moorhouse, J.L., J.J. Barnett, K. Djotni, C.L. Hepplewhite, C.W. P. Palmer, O.O. Oduleye, T. Walton, R.E.J. Waktins, J.G. Whitney, J.C. Gille, P. Arter, B. Nardi (2003), HIRDLS field of view calibration techniques and results, *Proc. SPIE*, **5152**, 193-203.

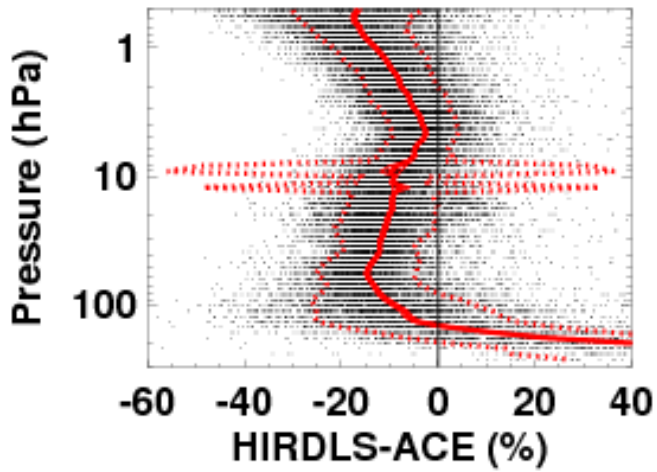
Ozone Comparison with ACE-FTS

ΔVMR

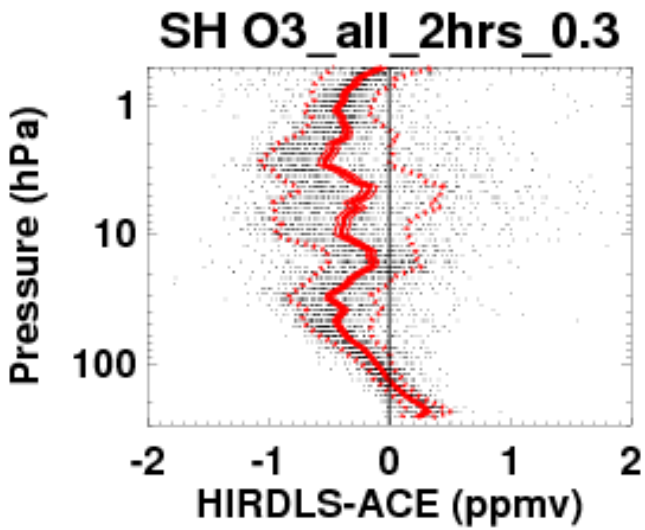
%Difference

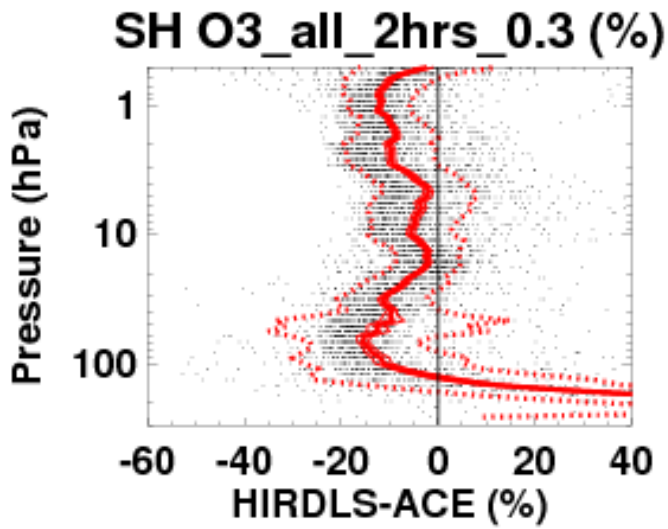
NH





SH

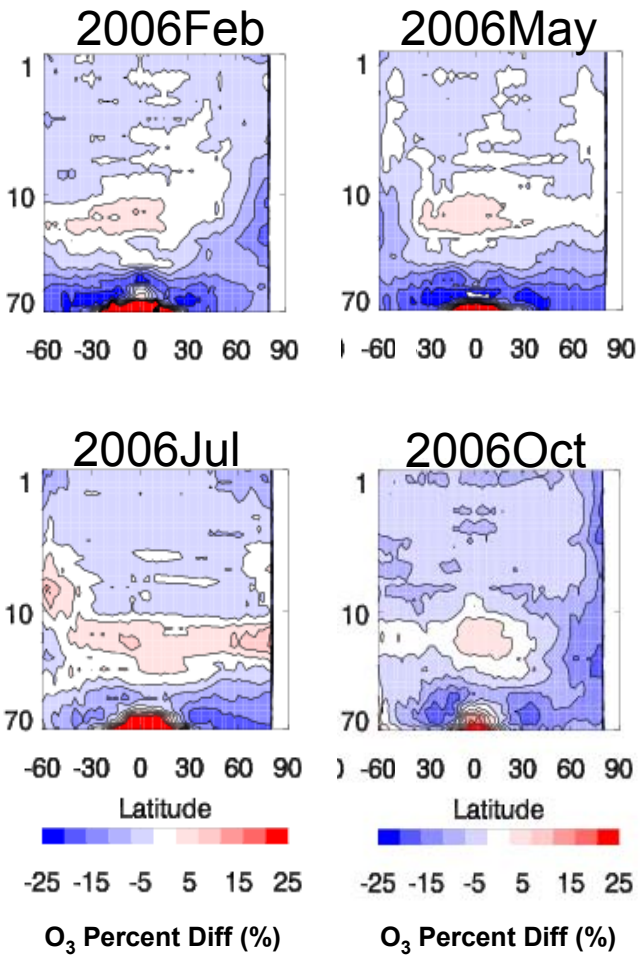




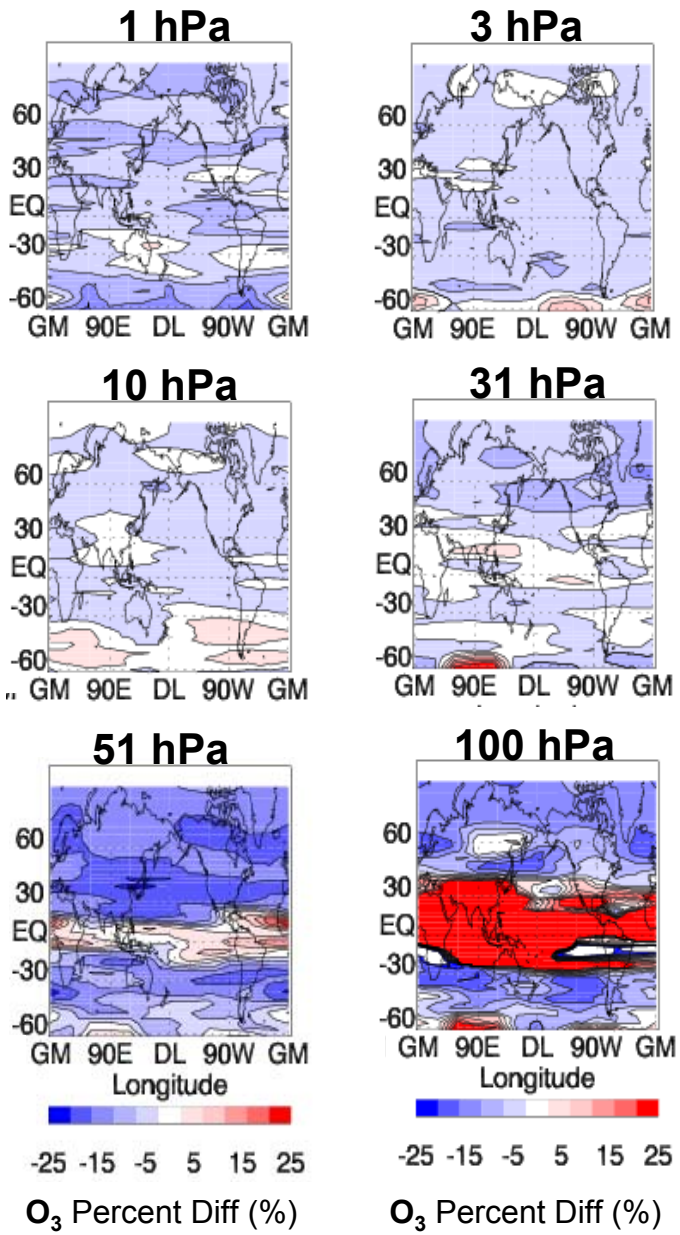
Cora Randall

Ozone

Comparisons with MLS v2.2 Ozone [Zonal Mean]



Comparisons with MLS v2.2 Ozone on pressure surfaces [Mercator]



V. Lynn Harvey